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Shining light on the Environmental TEM

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Digging into the world of photocatalysts by means of electron microscopy gives rise to new challenges. In order to study photocatalysts under working conditions, a holder capable of exposing a sample to visible light *in situ* during gas exposure in the ETEM has been developed at DTU Cen[1]. One of the major challenges when studying the effects of visible light in the electron microscope is to differentiate between the effect of visible light and that of high-energy electrons. New protocols for acquisition and robust interpretation of *in situ* data on photocatalysts are needed to minimize the effect of the electron beam without compromising image quality and information to exploit the full potential of *in situ* light stimuli.

A major parameter degrading the image quality in ETEM is the gas-electron interactions. Even though high-resolution ETEMs have been around for more than a decade little has been done in trying to understand the effects of gas-electron interaction on the image formation[2-4].

The addition of aberration correction and monochromation to ETEM has improved the point resolution and reduced image delocalization allowing for a more direct interpretation of surfaces and interfaces. Recently Yoshida *et al.* reported transmission electron microscopy imaging of CO molecules adsorbed on Au nanoparticles[5]. However, when gas is present in the microscope column the electron wave is modified due to gas-electron interactions[6, 7]. Several factors have to be taken into account when combining high-energy electrons with a gaseous environment. The fast electrons are scattered both elastically and inelastically by the gas molecules resulting in distortions of the electron wave both above and below the sample, thus altering the incoming and the exit wave carrying the image information. Furthermore, the interaction between fast electrons and gas molecules leads to ionization of the gas molecules. A full understanding of both the interaction of fast electrons with gas molecules and the effect of gas on high-resolution imaging is therefore necessary to take the next step towards quantitative ETEM.

Here, the case study of *in situ* Cu_2O photocorrosion is presented together with our ongoing work involving systematic measured images, diffraction patterns and energy-loss spectra acquired in gases in order to elucidate the influence of gas-electron interaction under imaging conditions suitable for *in situ* light experiments.

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